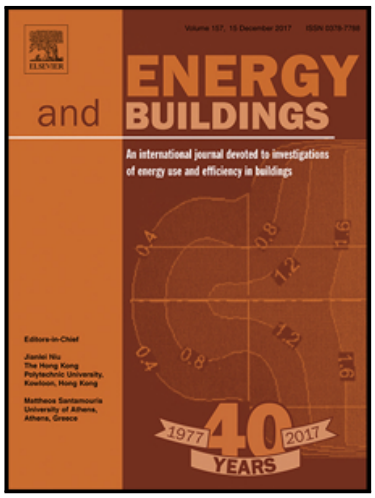

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Reduced-order Modeling for Energy Performance Contracting

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Abstract

Buildings subject to Energy Performance Contracts (EPCs) are usually quite complex public buildings, sometimes relatively old and usually barely documented from the technical standpoint. Gathering comprehensive and reliable technical information is a time consuming and expensive process that has to be carried out within the submission deadline. In these conditions, the standard approach to energy performance forecasting which uses detailed simulation is practically unfeasible.

This paper proposes a reduced-order modeling approach that is tailored to the EPC tendering phase. The proposed methodology extends a third order building model, introducing explicit, albeit still abstract, representations of the heating/cooling system, of the weather influence and of the end-user gains. The extended parameter set reflects to a large degree the information that is readily available in practical on-site surveying, or that can be easily calculated from that information. As a consequence of the simplified physics, a knowledge driven, practical calibration procedure, which provides an effective way of reducing uncertainty, is proposed. The calibration procedure analyses the uncertainty present in the available knowledge and uses the constraints imposed by the implemented physics on the parameters' dynamic to assess their value estimation.

The modeling approach is exemplified through three case studies: the first one provides the comparison of the reduced-order model predictions with the outcomes of a detailed model of a small hospital, the second one is used to compare the reduced-order model predictions with the detailed measurements of energy consumption of a real building, and the third case study exemplifies the use in operational context with scarce information.

Keywords: Reduced-order modeling, Energy performance contracting, Model calibration, Thermal modeling

1. Introduction

Energy Performance Contracts (EPC) are contractual obligations between a beneficiary and an energy service provider (normally an Energy Service Company - ESCO), where budgets are

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